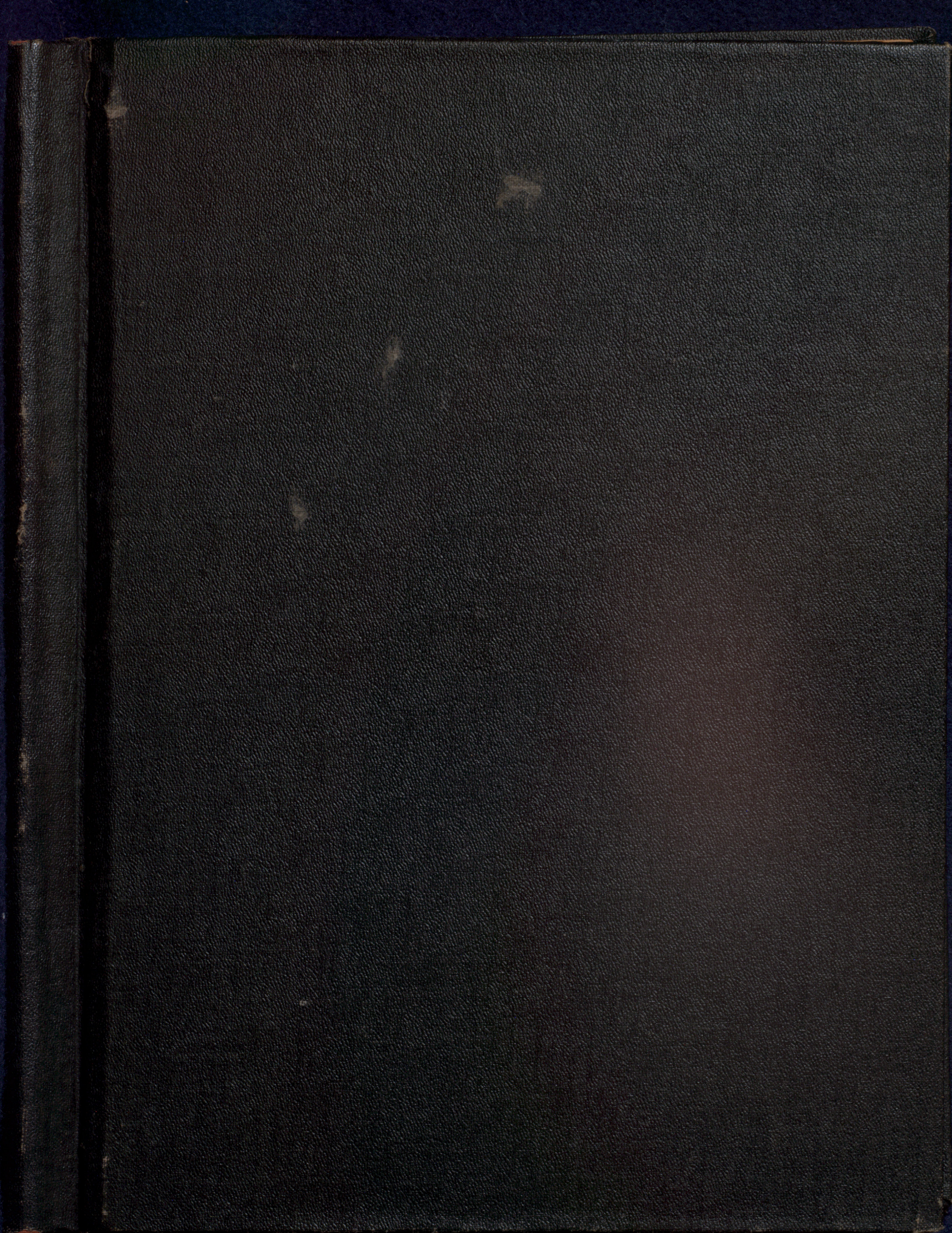




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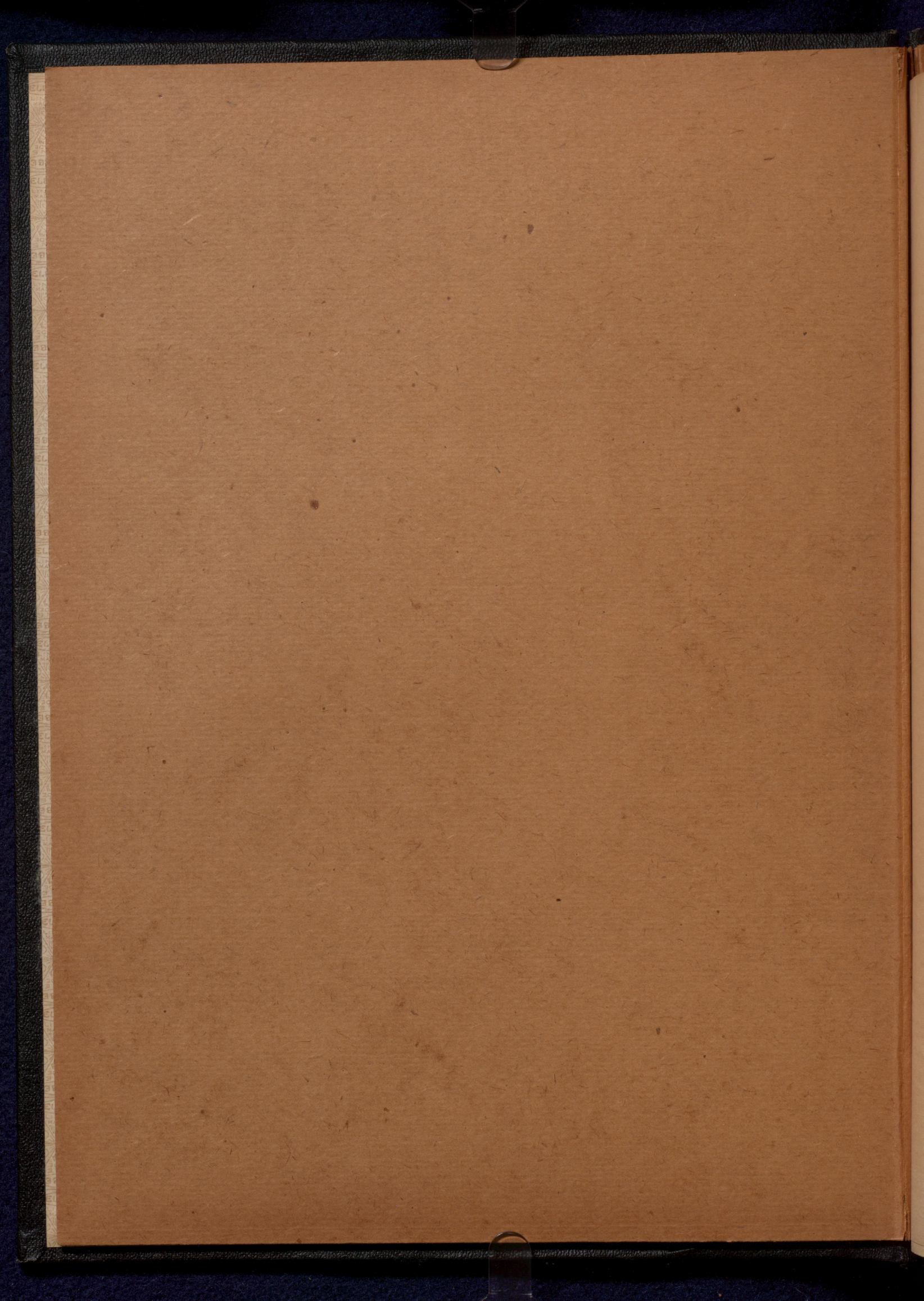
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ON CANADIAN FRESH-WATER POLYZOA^x

By William Osler M.D.

The Polyzoa, or Bryozoa, as they are sometimes called, form an exceedingly interesting group of animals. From their extensive distribution in geological formations and from the abundance and great beauty of the marine species at the present day, they have attracted an unusual share of attention from naturalists, while the elegance and plant-like appearance of many of the forms make them at the sea shore and in the museum favorites with the public. For a long time the Polyzoa were classified with the hydroid polyps among the Radiata, and even by Owen, in 1855, this method was adopted. Dr. J.V.Thompson, in 1830, was the first to separate them and apply the name Polyzoa to the whole class. At present they are classified as the lowest division of the Mollusca, forming together with the Tunicates and Brachiopods the class Heterobranchiata in the old system, or the division Molluscoida in the new. The Polyzoa are divided into two orders, 1st, the Phylactolaemata, in which the tentacles are arranged in the form of a horse shoe or crescent, and which are provided with a valve guarding the throat. 2nd, the Gymnolaemata, in which the tentacles are arranged in a circle, and the throat is not provided with a valve. In the Phylactolaemata there are three sub-orders, of which the first, Lophopea,

^xRead before the Natural History Society of Montreal. Republished from the Canadian Naturalist and Quarterly Journal of Science, Series 2, Vol X, No.7 Page 399-406. Published March 8th, 1883.



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contains almost all the fresh-water species. Prof. Allman divides the Lophopea into two great families, the Cristatellidae and the Plumatellidae - in the former the animal is locomotive, in the latter fixed. The genera in which Canadian species occur, as far as we know at present, are Cristatella, Plumatella and Pectinatella, and the five species which I have identified Cr. ophidioidea, Pl. diffusa, arethusa and vitrea, and Pect. magnifica.

As I have nothing new upon this subject to bring forward, I shall proceed to make some general remarks upon the structure and life history of these creatures, and demonstrate the specimens on the table before you. I may as well here explain one or two terms which will be frequently used in the descriptions. The term caenaecium when employed indicates the common system and solid basis of the animal. The external coating is called the ectocyst, the internal the endocyst, and the horse shoe shaped disk supporting the tentacles the lophophore - strictly the bearer of the plume. The first species to which I will direct your attention is the Pectinatella magnifica of Leidy, described by him in the proceedings of the Academy of Science of Philadelphia, for Nov. 1851, and defined as follows:- Caenaecium massive, gelatinoid hyaline, fixed, investing bodies. Orifices arranged in irregular lobate areolae upon the free surface. Lophophore crescentic. Ova Lenticular, with an annulus and marginal spines. The specimens on the table show well the hyaline

gelatinous nature of the caenaecium and the arrangement of the Polyps upon the surface. This is perhaps the most abundant fresh-water Polyzoon in the country, being found in the quiet waters about the mouths of the numerous streams, and in the small lakes. It is not very abundant in Quebec, but it has been found near St. Andrews, and I obtained a beautiful specimen from Lake Memphremagog. I have not seen it in the neighbourhood of Montreal. This species prefers quiet, still waters, not too much exposed, nor of large extent and subject to commotion from waves. Thus I have never found it in Lake Ontario itself, but always in little sheltered marshy bays, where it is found encrusting logs, upright sticks, and the stems of rushes. My attention was early directed to this form as it exists in extraordinary profusion in the Desjardin canal, which leads from Burlington Bay to my native town Dundas. The wooden sides of the canal basin in the months of July and August are almost uniformly covered with this magnificent species. The growth begins about $1\frac{1}{2}$ to 2 feet below the surface and extends in depth for the same distance or even further, rarely, however, deeper than six feet. The masses form extensive sheets usually a few inches in thickness, or else beautiful symmetrical projections, 6-12 inches in thickness, which spring either from a bed of the Polyps or are isolated. In the summer of 1867, during a visit of my friend, the Rev. W. A. Johnson, of Weston, I showed him the masses, and we agreed to subject them to examination with the microscope, not having any idea as to their real nature. Judge of our de-

celebrated nature of the vegetation and the arrangement of the
foliage upon the surface. This is perhaps the most striking
feature of the vegetation in the country, being found in the most
water about the mouth of the Hudson river, and in the
small lakes. It is not very abundant in Canada, but it has
been found near St. Lawrence, and I collected a beautiful speci-
men from Lake Champlain. I have not seen it in the north-
west of America. This species grows wild, still
water, not too much exposed, now of large extent and subject
to commotion from waves. Thus I have never found it in Lake
Superior itself, but always in little sheltered bays,
where it is found growing in large, rounded stones, and the
atoms of these. My attention was early directed to this
form as it exists in extraordinary profusion in the Hudson
canal, which leads from Burlington Bay to my native town Dun-
elm. The wooden sides of the canal basin in the mouth of
the Hudson are almost uniformly covered with this mar-
vellous species. The growth begins about 10 to 15 feet below
the surface and extends to depths of 200 feet or over
further, rarely, however, deeper than this. The species
forms extensive masses usually a few inches in thickness, or
also beautiful symmetrical projections, 6-12 inches in thick-
ness, which spring either from a bed of the larger or are loca-
ted. In the summer of 1857, during a visit of my friend,
Rev. W. A. Johnson, of Boston, I showed him the masses, and we
succeeded in subjecting them to examination with the microscope, not
having any idea as to their real nature. Indeed at our dis-

light when we found the whole surface of the jelly was composed of a collection of tiny animals of surpassing beauty, each of which thrust out to our view in the zoophyte trough a crescent-shaped crown of tentacles. Recognizing it as a Polyp we were greatly exercised as to its position, presenting as it did in the method of growth, such variation from the ordinary species described in our zoological text books. Happily in the American Naturalist for that year we met with Mr. Alpheus Hyatt's papers on the Fresh-water Polyzoa, then in course of publication, and obtained full information therefrom. On examining the surface of a mass of Pectinatella the polyps are seen to be arranged, as seen in the spirit preparation, in close areolae, which, being crowded and compressed together, often assume hexagonal outlines. From the periphery of these irregular areas the polyps project, the central part being as a rule unoccupied. When in the water the protrusion of the innumerable tentacles gives a fine velvety appearance to the surface, which entirely disappears on touching the polyps or agitating the water. This species is, however, much less timid than some others, and the polyps over even a small mass do not all withdraw on a slight irritation. The color of the polypidom is a light brown, or when the tentacles are extended, a faint rosy red hue, due to the color about the throat, glimmering through them. Towards the central part of the areolae, white, brown and dark spots are seen, representing oval at various stages of development. The caenaeecium composed of the

light when we found the whole surface of the jelly was composed of a collection of tiny animals of amazing beauty, each of which turned out to be a tiny jellyfish, forming a constant-shaped crown of tentacles. Recognizing it as a jelly we were greatly excited as to its position, presenting as it did in the method of growth, such variation from the ordinary species described in our scientific text books. It lay in the American Museum for that year as far as Mr. Alfred Hyatt's papers on the first water polypus, from its course of publication, and obtained full information. On examining the surface of a mass of tentacles the polyps are seen to be arranged, as seen in the entire preparation, in close series, which, being crowded and compressed together, often assume a hexagonal outline. From the periphery of these irregular areas the polyps project, the central part being a true anemone-like. When in the water the protrusion of the innumerable tentacles gives a fine wavy appearance to the surface, which entirely disappears on touching the jelly or exciting the water. This species is, however, much larger than some others, and the polyps over even a small mass do not all withdraw on a slight irritation. The color of the polypoid is a light brown, or when the tentacles are extended, a faint rose red hue, due to the color about the throat, rising through them. Towards the central part of the surface, white, brown and dark spots are seen, representing oval at various stages of development. The surrounding recesses of the

dense aggregation of polyps is closely united to the subjacent gelatinous mass, which constitutes here the ectocyst. On removal of the polyps the surface of the jelly presents patterns corresponding to the arrangement of the animals, irregular areas grooved in a radiate manner. The superficial portion of the ectocyst has often a reddish tint, and the deeper parts slightly greenish from the presence of a confervoid growth. Many masses of large size present a jelly perfectly colorless and pure throughout. Upon the development of this jelly, which is to be regarded as a definite excretion or secretion from the animal, the size of the polyp masses depends. When encrusting boards they are usually flat, larger conoidal projections occurring at intervals. Around the stems of rushes the most beautiful masses are found. The small one before you gives a good idea of the graceful symmetry of the growth. I have measurements of such a symmetrical cluster about a reed which was 14 inches in length and 10 in circumference, the weight 9 lbs. In some seasons the luxuriousness of the growth of these creatures is extraordinary. In the still quiet water in the marsh on either side of Desjardin canal, just before it passes through the Burlington heights, I have met with masses which would not go into a pail. The largest I have ever seen lay at the bottom in about nine feet of water. I could hardly believe it was a mass of polyps, but, to satisfy my curiosity, I stripped and went in for it. With the greatest difficulty I brought it up in my arms, but could not get it out of the

dense aggregation of polype is closely related to the subject
of the polype, which is situated near the subject. On re-
moval of the polype the surface of the jelly presents a pattern
corresponding to the arrangement of the animal. It is
evident that the animal is a radial member. The superficial portion
of the subject has often a radial edge, and the subject is
usually rounded from the base to a conical point.
Many masses of large size present a jelly surface which is
not quite transparent. Upon the development of this jelly
which is to be removed at a later date, a section of section
from the animal, the side of the polype mass is shown. When
constructing boards they are usually flat, larger rounded pro-
jections occur at intervals. Around the edges of these
the most beautiful masses are found. The small one before you
gives a good idea of the beautiful structure of the subject.
The measurements of such a specimen are about a foot
which was 14 inches in length and 10 in diameter. The
weight is 3 lbs. In some cases the thickness of the board
of these specimens is extraordinary. In the still dried state
in the water on either side of the subject, just before it
passes through the surface of the subject, I have not seen
which would not be into a ball. The largest I have seen
lay at the bottom in about one foot of water. I could hardly
believe it was a mass of polype, but to satisfy my curiosity
I stepped and went in for it. With the greatest difficulty
I brought it up in a net, but could not get it out of the

water for the weight, which must have been close upon 25 lbs. It resembled in form one of those beautiful masses known as brain coral.

On account of the colorless nature of the ectocyst and the extent to which the polyps protrude, this species is the most favorable to study the general arrangements of the organs, the perfect transparency allowing every detail in the structure to be seen. I have found it best to cut a thin vertical slice from the mass, containing on the surface not more than one or two rows of polyps, and examine in the zoophyte trough with a half-inch glass. It is much easier in this way to obtain a view of the complete animal than in the live box. The shock of the section and removal to the trough causes complete retraction of the polyps, and the surface of the caenacium looks smooth, or presents only slight tuberos elevations, corresponding to the situation of the orifices. On watching one of these, the sphincter closing it may be seen to relax, and the ends of the tentacles protrude through the orifice, feeling about from side to side as if to ascertain whether the "coast was clear". Finding no cause for alarm, the relaxation of the sphincter proceeds, the tentacles are pushed out still further, resulting at last in the complete evagination of the polyp. The beautiful crescentic tuft is arranged in the form of a horse shoe, or the letter U inverted, the tentacles spring from each side of the summit of the double outline, the mouth being at base. The number of the tentacles ranges from 50-80; they are

water for the weight, which must have been close upon 25 lbs.
It resembled in form one of those beautiful objects known as
brain coral.
On account of the delicate nature of the coral-
cyst and the extent to which the polyps protrude, this material
is the most favorable to study the general arrangement of the
organs, the perfect transparency allowing every detail in the
structure to be seen. I have found it best to cut a thin ver-
tical slice from the mass, containing of the corals not more
than one or two rows of polyps, and examine in the microscope
through with a half-inch glass. It is much easier in this way
to obtain a view of the complete animal than in the live coral.
The shock of the section and removal to the stage caused com-
plete retraction of the polyps, and the outline of the animal
now looks smooth, or presents only slight irregular elevations,
corresponding to the situation of the orifices. On withdrawing
one of these, the sphincter closing it may be seen to relax,
and the ends of the tentacles protrude through the orifice. They
lag about from side to side as if to ascertain whether the "object
was clear". Finding no cause for alarm, the retraction of the
sphincter proceeds, the tentacles are curled out still further,
resulting at last in the complete expansion of the polyp. The
beautiful cross-section is arranged in the form of a horse
shoe, or the letter U inverted, the tentacles arising from each
side of the summit of the dorsal outline, the mouth being at
base. The number of the tentacles ranged from 50-80; they are

sigmoid in outline and increase slightly in length at the extremities of the arms. The inner rows incline towards each other, the outer curve gracefully in the opposite direction. The surface of the tentacles is covered with cilia, which are in constant motion, creating a vortex, at the apex of which the mouth is situated. The tentacles act independently as well as in concert, and thrust and bend in any direction, pushing away objectionable matters which may have got into the throat, or are present in the neighbourhood. Frequently one of the large infusoria coming within the vortex is carried down and attempting to escape is prevented by the interlacement of the tentacles which bending over form a cage. The sensitiveness of these ciliated arms is extreme and through them the creature obtains warning of approaching danger, and instantly withdraws itself.

From beneath the crescentic lophophore the alimentary canal hangs, which presents the following parts for observation: the epistome, a valve-like projection overhanging the mouth, the oesophagus or throat, the stomach, intestine and anus.

The epistome is a tongue-like organ arising at the junction of the inner arms of the lophophore, and serves as a valvular protection for the mouth. It possesses a set of muscles by which it can be readily moved and jerks up and down very frequently. It appears to keep materials in the throat rather than prevent the entrance of anything obnoxious. Like the tentacles it is covered with cilia. All the parts about

the region of the epistome have a dark rose-red color, and this gives a peculiar brilliancy to the animals. A somewhat funnel-shaped mouth leads directly into the aesophagus, a short colorless tube, which widens slightly as it descends. A valve-like construction separates it from the stomach, into which, as soon as the aesophagus is full, the food is expelled by the contraction of the muscular walls.

The stomach forms an elongated tubular cavity in which the food is subject to a constant peristaltic action during the process of digestion. The lining membrane is plicated and the cells upon the folds are of a brown color, containing a fluid which Prof. Allman regards as a biliary secretion. The intestine or coecum is a short broad cavity separated from stomach by a valve and placed parallel to the aesophagus, opening by an anal orifice immediately beneath the lophophore. The undigested residue of the food is gradually pushed through the coecal valve and distends the intestine and is expelled by the contraction of the coecal walls and carried away by the action of the cilia of the tentacles. From the lower part of the stomach a cord-like process, the funiculus, extends, and connects it with the bottom of the caenaecium.

There is no definite circulatory system in the Polyzoa. A colorless fluid bathes the interior of the caenaecium and the perigastric cavity. By the action of the cilia which line the interior of the caenaecium currents are created which are rendered evident by the small particles carried round.

The region of the epiglottis has a dark rose-red color, and this gives a peculiar brilliancy to the animal. A somewhat funnel-shaped mouth leads directly into the oesophagus, a short colorless tube, which widens slightly as it descends. A valve-like contraction separates it from the stomach, into which, as soon as the oesophagus is full, the food is expelled by the contraction of the muscular walls.

The stomach forms an elongated tubular cavity in which the food is subjected to a constant peristaltic action during the process of digestion. The lining membrane is whitish and the cells upon the folds are of a brown color, containing a fluid which first, when regarded as a dilute secretion. The intestine or caecum is a short broad tubular structure separated from the stomach by a valve and placed parallel to the oesophagus, opening by an anal orifice immediately beneath the forepharynx. The undigested residue of the food is gradually pushed through the anal valve and distends the intestine and is expelled by the contraction of the coecal walls and carried away by the action of the cilia of the tentacles. From the lower part of the stomach a coel-like process, the tentacles, extends, and connects it with the bottom of the oesophagus.

There is no definite circulatory system in the "polyps". A colorless fluid bathes the interior of the stomach and the pericardial cavity. By the action of the cilia which line the interior of the coelomic cavity are created which are rendered evident by the small particles carried round.

Respiration is probably carried on by the cilia covering the tentacles, but our knowledge of this function is extremely slight.

The nervous system of the fresh-water Polyzoa is represented by a definite ganglion which lies in the neighbourhood of the aesophagus, immediately below the epistome. It is easily seen in *Pectinatella* and presents curious contractions and expansions. By these the position of the mass is altered, sometimes approaching nearer the aesophagus, at others being in the hollow of the epistome. Nerve branches may be seen proceeding from this ganglion chiefly towards the epistome and tentacles.

The muscular system is well developed and the muscles form either sphincters or elongated branches. A definite sphincter surrounds the orifices of the caenaecium and closes them tightly when the polyps are retracted, relaxing again for their protrusion. The longitudinal bands arise from the base of the caenaecium, and passing up are distributed in three different localities, on the stomach, the base of the lophophore, and the tentacles, and are called respectively the gastric, lophophoric and brachial retractions. By the action of these muscles the little animal can be instantaneously withdrawn, and the sphincter closing effectually shields them from injury and attack. Other muscles are described by Hyatt and Allman, in connection with the epistome and endocyst.

The *Phylactolaemata* are reproduced by budding and true ovulation. From the side of the polyps buds arise which

Respiration is probably carried on by the gills covering the tentacles, but our knowledge of this function is extremely slight.

The nervous system of the Fresh-water Polyp is represented by a definite ganglion which lies in the neighborhood of the oesophagus, immediately below the pharynx. It is easily seen in *Hydra* and presents various contractions and expansions. By these the position of the mass is altered, sometimes approaching nearer the oesophagus, at other times in the hollow of the pharynx. Nerve branches may be seen proceeding from this ganglion obliquely towards the epistome and tentacles.

The muscular system is well developed and the muscles form either sphincters or elongated bundles. A definite sphincter surrounds the orifice of the oesophagus and closes them tightly when the polyp is retracted, relaxing again for their protrusion. The longitudinal bands arise from the base of the oesophagus, and passing on are distributed in three different localities, on the stomach, the base of the pharynx, and the tentacles, and are called respectively the gastric, pharyngeal and brachial tentacles. By the action of these muscles the little animal can be instantaneously withdrawn, and the sphincter closing effectively shields them from injury and attack. Other muscles are described by Hyatt and Allen, in connection with the epistome and endostyle.

The Epistome is a structure formed by budding and from the side of the polyp tube arises which

develop into mature forms and in this way the colonies are increased. Another method of budding results in the production of free gemmae or statoblasts, which arise from the funiculus. These present a horny sheath, usually dark brown in colour, and an annulus or margin, which in some species is provided with spines. In *Pectinatella*, the spines number from 12-20, in *Cristatella* there is a double row, one shorter, the other longer, 50-60 in all, and the extremities are furnished with from 4-6 hooklets. The statoblasts float on the surface of the water and the armed ones get entangled in the weems.

The method of production of true ova was first described by Allman. They originate in a bud-like mass at the upper side of the endocyst and are fertilized by spermatozoa, the testicles being an offshoot from the funiculus.

In the genus *Plumatella* I have determined three Canadian species, *arethusa*, *vitrea*, and *diffusa*. The members of this genus have dendritic, plant-like caenaecia, which are firmly attached to the surface of submerged twigs, stones and water-plants. The caenaecium is composed of little hollow branched tubules, divided into cells from the apex of which the little polyp protrudes, while at the other end it is in communication with the parent polyzoon. The branches are generally attached along the greater part of their length, though sometimes, as in this specimen of *P. arethusa*, they are free in nearly the whole extent. The color is owing to the ectocyst which when first secreted is thin and jelly like but soon becomes consistent, and at last dark brown. The endocyst lies immediately within this and is contin-

develop into mature forms and in this way the colonies are in-
creased. Another method of budding reported in the production
of new colonies of *Dictyostelium*, which arises from the fruiting
bodies present a horny sheath, usually dark brown in color, and
an annulus of muscle, which in some species is provided with
spines. In *Dictyostelium*, the spores number from 10-20, in
Dictyostelium there is a double row, one anterior, the other posterior,
30-40 in all, and the spores are furnished with thin 4-6
microns. The spores are first on the surface of the water
and the spores are not contained in the water.
The method of production of new colonies is
described by Wilson. They originate in a bud-like mass at the
inner side of the anterior and are fertilized by a posterior.
The ventral surface is attached from the posterior.
In the genus *Dictyostelium* I have determined that
the species *Dictyostelium*, *Dictyostelium*, and *Dictyostelium*. The members of
this genus have distinctive, plant-like characters, which are likely
attributed to the surface of substrate, water, and water.
The organism is composed of little hollow branches
which, divided into cells from the apex of which the little
cells protrude, while at the other end it is in communication with
the parent organism. The branches are generally attached along
the greater part of their length, though sometimes, as in this
species of *Dictyostelium*, they are free in nearly the whole extent.
The color is owing to the carotene which first enters the
cells and jelly like and soon becomes concentrated, and at last dark
brown. The carotene is immediately within this and is contin-

tinuous throughout the system of branches.

The species of this genus are widely distributed throughout Canada in the quiet ponds and marshes attached to twigs, submerged logs and the under surface of the leaves of the water lily.

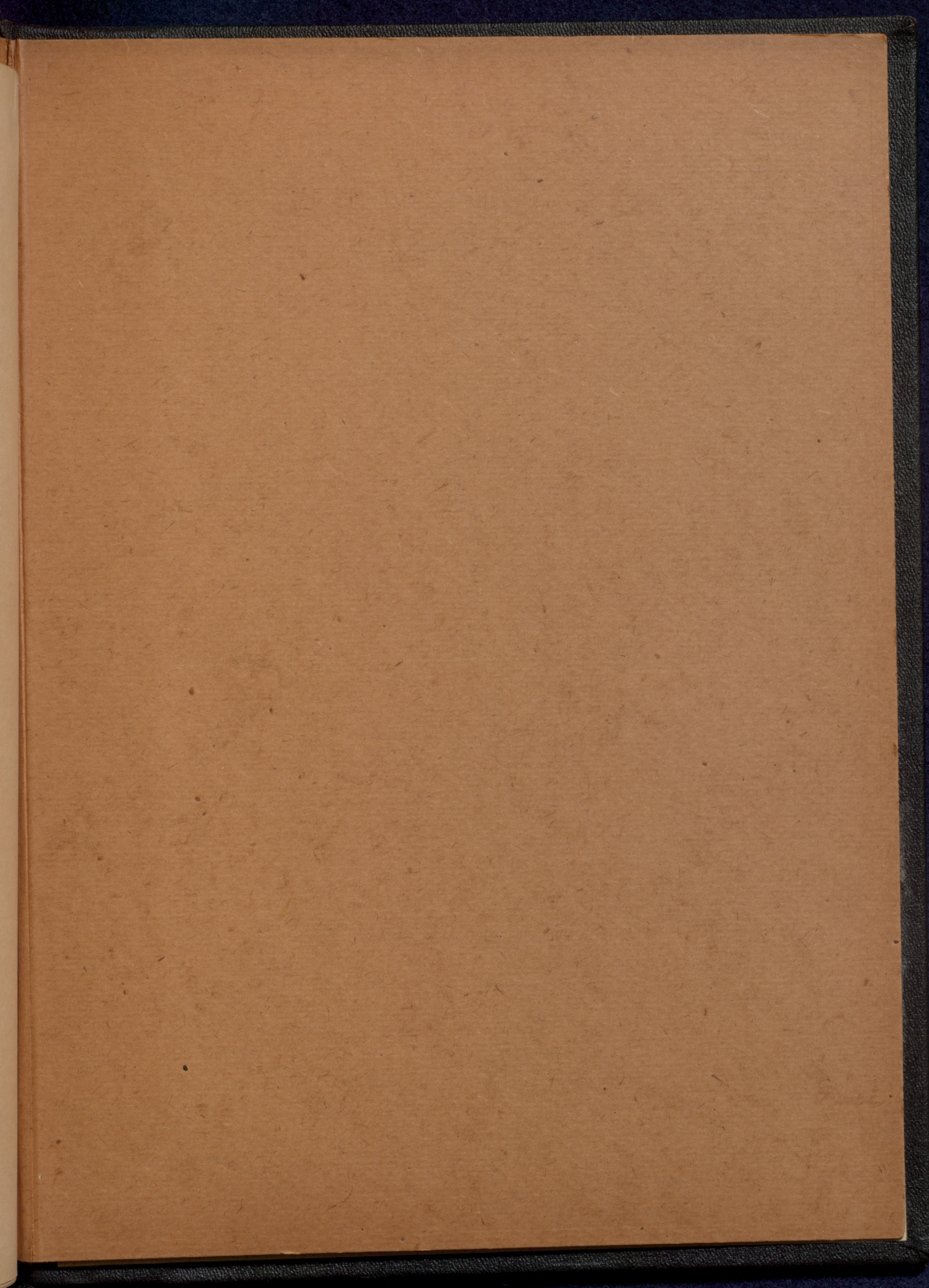
The Cristatellidae, the most highly organized of the Polyzoa, have a locomotive caenaecium. There are ^{to} American species *C. Idae* and *C. ophidioides*. The one which I have studied here confirms to the latter, as described by Hyatt, in both statoblasts and number of tentacles. It is not nearly so common as the other forms. I have on several occasions met with the statoblasts in gatherings, but have never found the polyp except in the small lakes near the summer residence of Mr. G. W. Stephens, in the County of Maskinonge, Quebec. In Lac Rouge, the rocks at water's edge, at about the depth of from one to two feet, presented numerous specimens about an inch and a half to two inches in length and one-third of an inch in breadth. The movement was slow, in those which I observed in a small basin, not more than an inch in the 24 hours. The statoblasts differ from those of *Pectinatella* in possessing a double row of hooklets with from two to six points.

NOTE:- I have received from the Rev. Thomas Hincks, the distinguished authority on British Polyzoa, a reprint from the Annals and Magazine of Natural History for March, 1880, entitled "On a supposed Pterobranchiate Polyzoan from Canada". It is based on a communication from his father, the late

simultaneous throughout the system of branches.
The species of this genus are widely distributed
throughout Canada in the moist north and various attached
to twigs, submerged logs and the under surface of the
leaves of the water lily.
The crustacean, however, is very abundant
at the bottom, near the bottom of the water.
The species of this genus are widely distributed
which I have mentioned here, but in the latter, as has
noticed by Hyatt, is not abundant and number of specimens.
It is not nearly so common as the other forms. I have
examined specimens not with the same frequency in water,
but have never found the same extent in the water.
near the bottom of the water of Mr. H. H. Hyatt, in the
county of Alameda, Mexico. In the water, the water
of water's side, at about the depth of three feet in the water,
proceeded numerous specimens about an inch and a half
two inches in length and breadth of an inch in breadth.
The movement was slow, in some cases, I observed in a small
basin, not more than an inch in the water. The water
distant from the bottom of the water, in some cases, I
found a row of specimens with their feet in the water.

NOTE: I have received from the Hon. James F. Smith, the
Assistant Secretary of the United States, a specimen from
the United States of Mexico, from the State of Mexico,
collected by a named person, from the State of Mexico,
it is based on a description from his letter, the late

Professor Hincks, of Toronto University, in which a short account is given of a polyzoon found on a sunken boat in the Humber river, near Toronto. According to the description "the tentacles, instead of being disposed in a horse-shoe figure and forming a continuous series, as in the ordinary fresh-water species, are borne on two distinct erect lobes, which are separated at the base", the arrangement met with in the Pterobranchiate Polyzoa. At the date of Professor Hincks' letter, Dec. 1868, I was a student in his Natural History classes, and during the autumn of '68 had often taken him specimens of various sorts, and among them a mass of Pectinatella, which I had found in an old submerged barge near the mouth of the Humber. I remember the fact very distinctly, as it was the first specimen of Pectinatella which I had found near Toronto, and Professor Hincks took a great interest in it, as he had not met with any fresh-water Polyzoa in Canada. Could this have been the specimen? It is a curious coincidence, to say the least, and perhaps in a look through the Museum of the University the specimen might be found, and the statoblasts would be sufficient to decide the question. Professor Hincks gives a sketch of the lophophore and it is hard to think that he could have been mistaken as he was an unusually skilful observer. The submerged barge was for many years a favorite collecting ground, and in some seasons Pectinatella was very abundant in the quiet water inside of it.



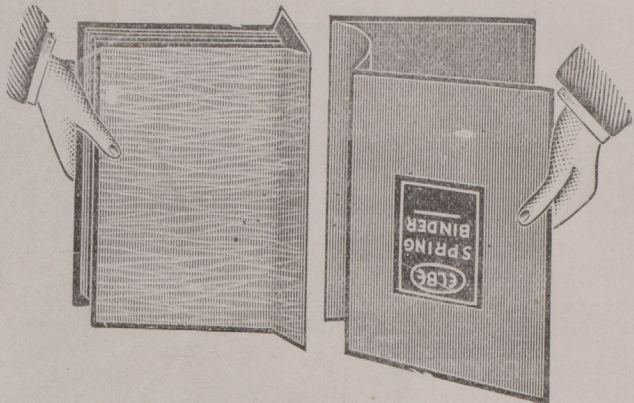
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